



Solar PV Manufacturing in India

Silicon Ingot - Wafer- PV Cell- PV
module

- TERI

Wednesday
07 August 2019

Drivers

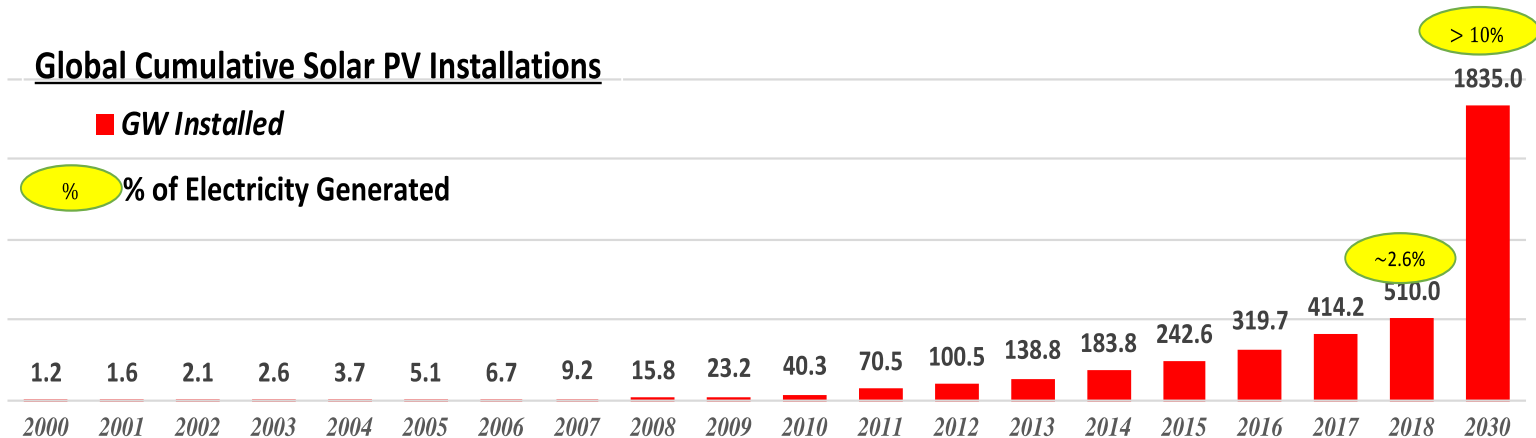
- National goal of 100,000 MW of solar power by 2022.
- Goal to continuing the growth trend beyond to be able to achieve 40% of non-fossil fuel power by 2030.
- Leveraging the size of domestic market is one of the key strategies adopted world over and China has used it to emerge as the global manufacturing hub.

Solar Energy will grow from 2% of global electricity generation today to >10% by 2030

Global Cumulative Solar PV Installations

■ GW Installed

○ % of Electricity Generated

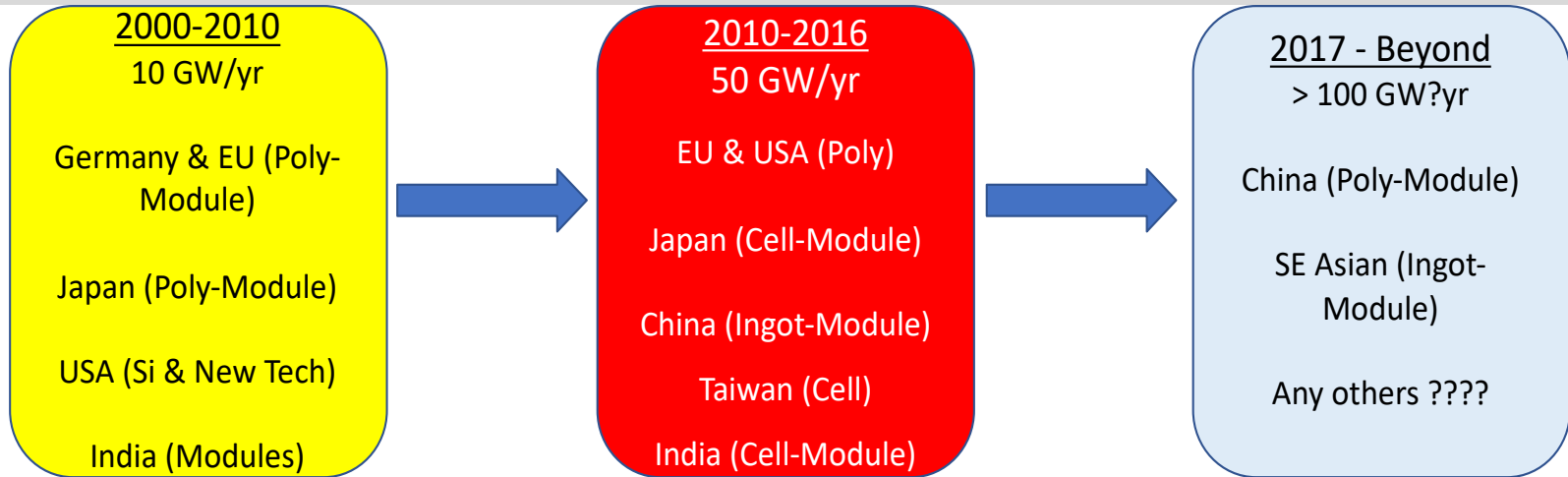


Gol Efforts

- Gol made a beginning to require bidders to use domestically manufactured solar PV modules in first ever solar bid of 150 MW, except for thin film and Concentrator PV technology in 2010.
- The stipulation was further strengthened in the second bid of 350 MW to require bidders to use only the domestically produced solar cells and modules.
- Later, schemes were launched to reserve 50% of the bid capacity for domestically manufactured solar cells and modules with differentiated provision to provide viability gap funding (VGF) with higher amount for DCR category.
- Recent bids by SECI linking setting up manufacturing capacity with assured PPAs

PV Manufacturing - Evolution

MIGRATION OF SOLAR PV MANUFACTURING

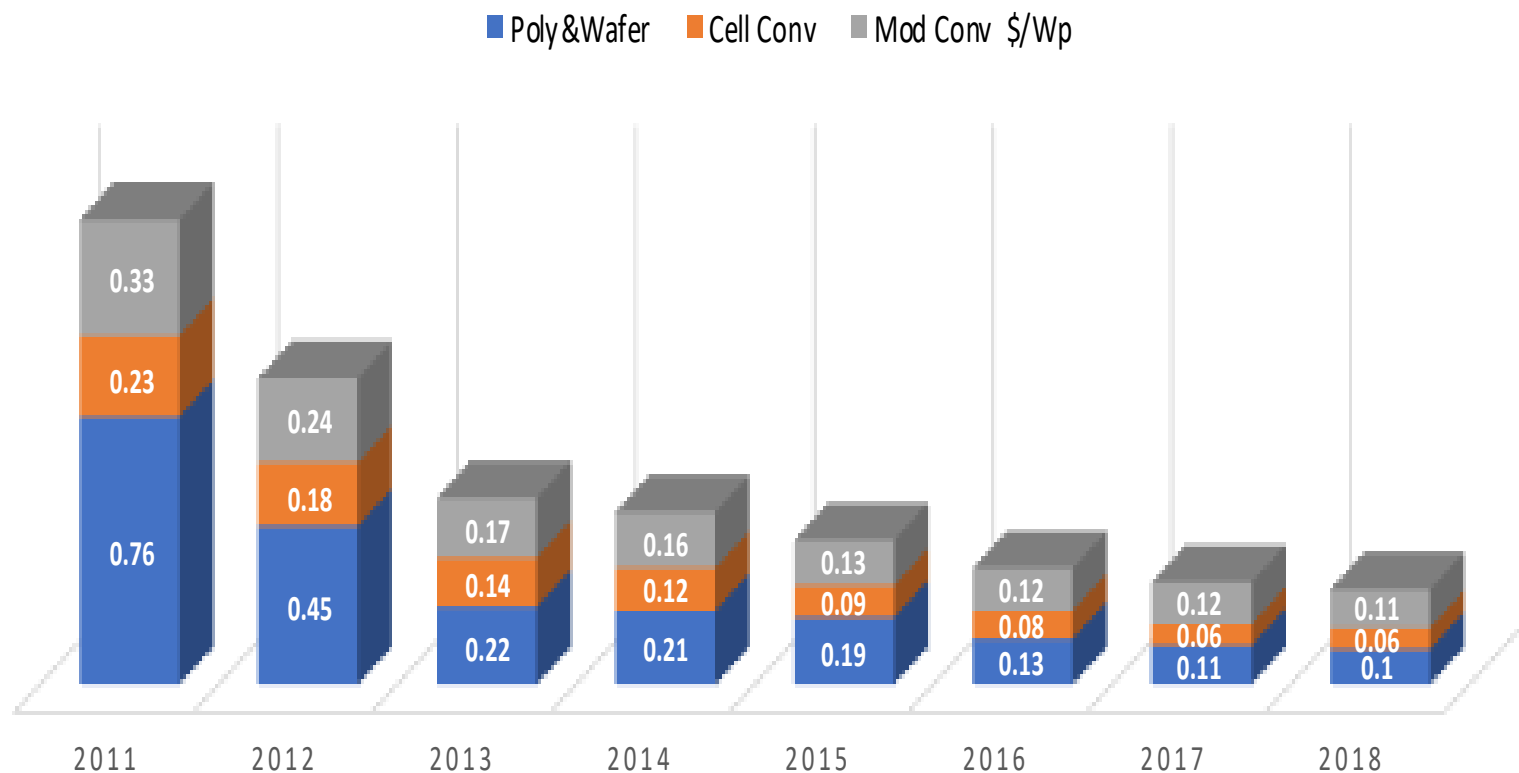


MIGRATION OF PV MANUFACTURING EQUIPMENT SOURCES



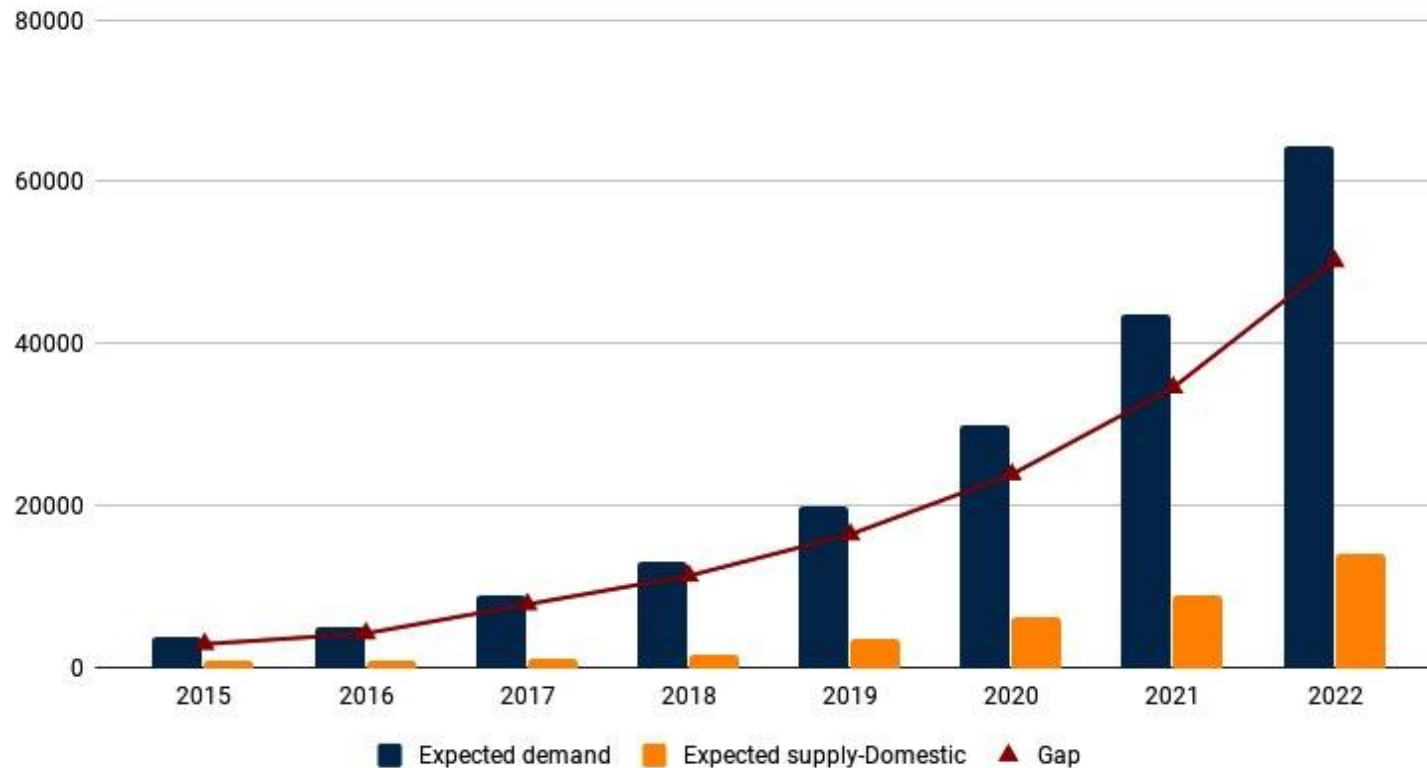
Decline in Prices of PV Module

INTEGRATED PV SOLAR MANUFACTURING COST , \$/W



Expected Manufacturing Growth in India

Expected scenario for solar manufacturing in India



Integrated PV Manufacturing costs: Chinese Tier-1 company and India

- **Economies of scale:**
3-5GW scale as against 0.5-1 GW capacity in India;
- **Project Finance**
India: 10-13% interest loans, comparatively shorter loan durations
China: 0-5% per annum interest loans with long tenures by government along with grants.
- **Plant & Machinery**
In India, fully imported from China / Europe at higher costs. In other countries, these are designed & fabricated locally by Manufacturing companies and tax set-offs are available
- **Land & Buildings**
Full costs to be absorbed by the project. Local govt. provides land & ready -to-occupy buildings on lease basis or at subsidized rates in other countries.
This results in total project cost for Indian companies being higher by around 15-25%.

Integrated PV Manufacturing costs:

Operational Costs

- **Raw Material Cost:**

High as majority of it have to be imported and eco-system existence is poor in India;

- **Yield Losses & recoveries**

Higher due to manual / semi-auto / lack of know-how in India; it is lower in other countries due to high automation / precision manufacturing and own R&D for improvements

- **Utilities**

Very high power tariffs in India.

- **Interest rates -Working Capital**

Higher interest rates of 12-14% in India as against interest rates of 2-4% in other countries;

- **Manpower cost**

In India, higher due to semi-automation resulting in lower productivity

Rationale for Decision Making

- PV manufacturing value chain starts from mining of Quartz Silica to PV Module manufacturing.
- High grade quartz silica (containing about 99.8% SiO₂) suitable for semiconductor grade Silicon manufacturing is available in natural hillocks located in AP, Karnataka, Orissa regions.
- The quartz (SiO₂) is converted to silicon (Si) by elaborate chemical process. For production of 1kg of MG Silicon, 2.6 kg of Quartz Silica is used along with. The power requirement is about 11-13 kWh/kg of Metal Grade (MG) Silicon. The cost of power is nearly 50-60% of the manufacturing cost of MG Silicon. Countries have allocated hydro-power.
- The report does not suggest manufacturing of MG Silicon.
- MG-Si of 2N is purified to 6-11N purity. The availability of state-of-the-art technology consisting of low power utilisation (<40 kWh/kg); high quality 6-9N is available from USA & China. The cost of power will be 20-35% of the manufacturing cost.

- Even after 10-years of manufacturing experience in Polysilicon at global scale capacities and access to global R&D, China is still not able to manufacture Polysilicon of higher quality (>7N) which is required for CZ **Mono wafer** (ultra-High Efficiency PERC & N-type cells) manufacturing. This high quality polysilicon is manufactured only by 4-5 companies located in South Korea, Germany, USA, Japan, who guard the technology very closely.
- There is enough global capacities available for manufacturing of polysilicon, and, therefore, rationale for decision to go for manufacturing is self-reliance with an aim to sustain our own national solar programme without any hiccups under circumstances of International issues.

Recommendations

- Government should consider prioritizing PV manufacturing value - chain as **Strategic Industry**.
- We may target at least 15 GW of **“full value chain Silicon Ingot to solar modules”** local manufacturing capacity operational with competitive prices by 2024.
- **Phased Manufacturing Programme (PMP)**, under Make in India plan could be initiated.

Recommendations : Phase I

Solar Cells and Modules :

- ❖ About 15 GW capacity could be targeted over a period of 2-3 years for manufacturing of cells and modules with full value addition in India.
- ❖ EoIs could be invited for approval aiming supply to commence in 2021.
- ❖ **Scale:** Investors will be keen to install GW scale plants. Minimum capacity could be 1 GW for eligibility for participation.
- ❖ **Technology:** Investors may be encouraged to go for best in class technologies like PERC+/HJT/TOPCON with different efficiency and cost structure. It is suggested that to go for '**Rs per Wp**' criterion to decide priority amongst the applicant developers.

Recommendations : Phase I – Contd.

- ❖ **Manufacturing Hubs:** Creation of solar manufacturing hubs, something on the lines of Solar Parks could speed up the process. Each hub can be designed to accommodate 4-5 GW of Solar PV manufacturing along with all the ancillary industries.
 - **Land:** 200 – 500 acres (developed land to be provided on lease basis to the selected manufacturers)
 - **Power:** 250-400 MVA (220 KV or 440KV to meet stable power requirement)
 - **Water:** 5 - 10 MLD
 - **Waste Water Treatment:** 2-7 MLD with adequate recycling facilities
 - **Solid Waste Handling:** 1000 Tons/year facility (with 10-20 year design capacity)
 - **Duties & Taxes:** Allowing duty free imports of all plant, machinery and spares.
 - **Environmental Clearances:** Waiver on environmental clearance with necessary safeguards for waste disposal is suggested.

Recommendations : Phase I – Contd.

- ❖ **Production linked Incentive:** It has been estimated that there could be a price differential of about Rs. 20 lakh per MWp for domestically manufactured solar cells and modules. The companies who will be entering into manufacturing under this scheme could be provided production linked incentive to the tune of this amount.
- ❖ **Green Manufacturing Fund:** Green Manufacturing Fund could be created by the Government out of NCEF. Alternatively, production linked incentives could be supported through funds collected i) through realization of safeguard duty, and ii) by levying a cess of Rs. 20 lakhs per MWp on imported solar modules.

Recommendations : Phase II

Integrate INGOT-WAFER & BOM ECO SYSTEM

- ❖ This phase is to graduate to add backward integration facilities to reach the stage of ingot-wafer-cells-modules manufacturing capacities.
- ❖ Total target capacity is 15 GW.
- ❖ **It is recommended to allow duty free imports of all plant, machinery and spare.**
- ❖ **In order to** compensate higher cost of financing and to make the product cost competitive, **capital grant on the** lines of the provisions of MSIPS is recommended which is upto 20% of the project cost, on reimbursable basis to the manufacturers.
- ❖ Two trenches of equal amount could be considered for disbursement of capital grant; first on the receipt of the machinery at the project site, and the second on commissioning of the facility.
- ❖ In addition, making available power at a tariff of about Rs. 2.00 per kWh would be necessary to keep operational costs competitive and having no necessity to consider providing recurring production linked incentives.

Recommendations : Phase III

With 10-20 GW manufacturing in-place, the domestic PV Value chain can be expanded to the Plant & Machinery equipment fabrication domestically.

Phase I - III

Comprehensive R&D programme by the Government around manufacturing plants with defined targets and goals for enhancing competitiveness of the industry.



Thank You